Executive Summary

Introduction

The Columbia River is a critical resource for residents of the Pacific Northwest. It provides for basic needs and is interrelated with the life style and quality of life for the Columbia Basin's many human and non-human residents. This resource was one of the key features that drew the Manhattan Project's planners to the site now called Hanford to produce nuclear weapon materials. Production of those materials has left behind a legacy of chemical and radioactive contaminants and materials that have affected and may be continuing to affect the Columbia River for the foreseeable future.

> We are conducting the Columbia River Comprehensive Impact Assessment in phases. The first phase is a screening assessment, the results of which are presented in Part I of this report. In the screening assessment, we evaluated the potential impact to the Columbia River resulting from current levels of Hanford-derived contaminants. The results of the screening assessment will be used to support decisions on Interim Remedial Measures. Part II of this report defines the requirements to conduct a comprehensive assessment of the Columbia River.

To evaluate the impact to the river from the Hanford-derived contaminants, the U.S. Department of Energy, U.S. Environmental Protection Agency, and Washington State Department of Ecology (the Tri-Party agencies) initiated a study referred to as the Columbia River Comprehensive Impact Assessment (CRCIA). To address concerns about the scope and direction of CRCIA as well as enhance regulator, tribal, stakeholder, and public involvement, the CRCIA Management Team (CRCIA Team) was formed in August 1995. The CRCIA Team has met weekly to share information and provide input to decisions made by the Tri-Party agencies concerning CRCIA. Representatives from the Confederated Tribes of the Umatilla Indian Reservation, Nez Perce Tribe, Yakama Indian Nation, Hanford Advisory Board, Oregon State Department of Energy, Tri-Party agencies, and Hanford contractors are active participants on the team.

The CRCIA Team has agreed to conduct CRCIA using a phased approach. The initial phase, which is required and described in Tri-Party Agreement milestones M-15-80 and M-15-80C-T01 (Ecology et al. 1994), includes two components: 1) a screening assessment to evaluate the potential impact to the river, resulting from current levels of Hanford-derived contaminants in order to support decisions on Interim Remedial Measures, and 2) a definition of the essential work remaining to provide an acceptable comprehensive river impact assessment. The screening assessment is described in Part I of this report. The essential work remaining is described in Part II of this report.

Additional phases of CRCIA will be identified and decisions made regarding the conduct of the remaining work based on submittal of information as required by Tri-Party Agreement milestones M-15-80A, M-15-80B, and M-15-80B-T01.

Part I. Screening Assessment

The purpose of the CRCIA screening assessment is to support decisions on Interim Remedial Measures and to focus a subsequent and more comprehensive assessment. The objective of the screening assessment is to identify areas where the greatest potential exists for adverse effects on humans or the environment. The Hanford Reach of the Columbia River was evaluated in the screening assessment in a way that will be useful in the CERCLA process but not necessarily in strict accordance with CERCLA procedures (for example, risk assessment methodology and remedial decision making). The screening assessment focused on a sub-set of potential contaminants, selected from a relatively broad set of possible contaminants. Part I of this report discusses the scope, technical approach, and results of the screening assessment. The screening assessment was conducted by the Pacific Northwest National Laboratory in consultation with the CRCIA Team.

Scope

The scope of the CRCIA screening assessment is to evaluate potential risk to the environment and human health resulting from current levels of Hanford-derived contaminants. The study area for the screening assessment (see Figure 1 in the Site Characterization section) extends from upstream of the Hanford Site in areas unaffected by Hanford Site operations down to McNary Dam, which is the first dam downstream of the Hanford Site. The specific parameters of the scope are:

- Human health risk
- Ecological risk
- Columbia River and adjacent riparian zone (vicinity of Priest Rapids Dam to McNary Dam)
- Current conditions: January 1990-June 1996 (most recent date of data used in the screening assessment)
- Contaminants of interest
  - Radionuclides: tritium (hydrogen-3), carbon-14, cobalt-60, strontium-90, technetium-99, iodine-129, cesium-137, europium-152, europium-154, uranium-234, uranium-238, neptunium-237
  - Carcinogenic chemicals: benzene, chromium
  - Toxic chemicals: ammonia, chromium, copper, cyanide, diesel constituents (diesel oil, kerosene, xylenes), lead, mercury, nickel, nitrates, nitrites, phosphates, sulfates, zinc

- Environmental media

  - Direct use: Columbia River water, riverbank seep water, river and seep sediment, external radiation

  - Indirect use: groundwater (surrogate for seep water), riparian soils, aquatic and riparian biota (used for model comparison, verification)

Technical Approach

A screening assessment by its very nature is a limited assessment. Such limited assessments are used to indicate whether the issues under study warrant further investigation. Screening assessments are often used to express risk in relative terms rather than absolute because of the number and type of assumptions required to drive risk models, the degree of uncertainty inherent in the input to the models, and the limitations in available environmental data. The assumptions, uncertainties, and limitations are applied consistently across the study area, resulting in useful information relative to risk.

While more detailed than typical screening level assessments, limitations to the CRCIA screening assessment have been identified. The CRCIA screening assessment was restricted to 1) current conditions, 2) the Columbia River and adjacent riparian zone between Priest Rapids Dam and McNary Dam, 3) a limited number of contaminants, 4) a limited amount of monitoring data, 5) a limited number of species, and 6) a limited number of scenarios. For the results of the assessment to be useful, these limitations and the process through which the study was conducted must be understood.

The screening assessment technical approach is summarized through the following activities:

- Determining study domain and spatial scale

- Identifying contaminants to be assessed (resulting in 26 contaminants, 28 when accounting for various constituents of those contaminants)

- Identifying a variety of species to evaluate ecological exposure to the contaminants (resulting in 52 species)

- Identifying a variety of exposure scenarios to evaluate human exposure to the contaminants (resulting in 12 scenarios)

- Identifying, collecting, and preparing monitoring data available for the contaminants

- Assessing risk to human health and the environment posed by exposure to the contaminants

Study Domain and Spatial Scale

The study area was first broken down into 27 segments to best represent the current environmental conditions and the state of knowledge relative to contaminant concentrations in the river environment. The segmentation also provides meaningful information associated directly with the site operable units that will be useful in evaluating future remedial actions. Selection of the segments was based in part on environmental measurement densities, existing data representativeness, historical operations, and site knowledge of contaminated groundwater plumes entering the river. Some adjustments in the borders and size of individual segments were made as a result of CRCIA Team consultation and recommendations. Human health and ecological risk assessments were performed on the segments individually to provide a consistent basis on which to determine areas of potential concern.

Contaminants of Interest

The approach to estimating risk to the environment and humans began by determining which contaminants should be evaluated in the screening assessment. Contaminants of interest were identified prior to completing the source term data collection activity to focus the data gathering efforts on the specific contaminants to be evaluated in the assessment. This contaminant identification process, described in Section 2.2, consisted of a review of easily available records and was based on process knowledge and environmental measurements in surface water, riverbank seeps, soils, sediments, and groundwater. The initial list contained nearly 100 potential Hanford-origin contaminants.

The initial list of 100 potential contaminants was screened (using a multi-stage screening process described in Section 2.3) to a manageable number of contaminants likely to produce the greatest environmental or human health risks. This process was based on screens for human toxicity, human carcinogenicity, acute and chronic aquatic biota toxicity, and water quality standards. The final contaminants of interest list was established to provide reasonable assurance that the dominant contributors to human and ecological risk were included in the screening assessment. Additional consideration was given to contaminants known to be of public, stakeholder, or tribal concern. As a result, a list of 26 contaminants of interest was established that would be included in the human health and ecological assessments.

Species of Interest

A master species list, consisting of 368 species known to exist between Priest Rapids Dam and McNary Dam, was established that became the basis for the selection of the species to be included in the screening assessment. From the master list, a Tier I list of 93 species was generated by ranking the master list against 6 criteria. The CRCIA Team added 88 additional species to the Tier I list. Tier II ranking, a qualitative ranking of the Tier I list, resulted in the selection of 52 species to be included in the screening assessment. The Tier II ranking provided for balance across taxonomic groups and exposure pathways. The list of 52 species includes (see Section 4.1 and Appendix I-C):

Algae - periphyton, phytoplankton

Amphibians - Woodhouse’s toad

Aquatic invertebrates - clams/mussels/snails, crayfish, fresh water shrimp, mayfly, water flea

Birds - American coot, American kestrel, American white pelican, bald eagle, California quail, Canada goose/mallard, cliff swallow, common snipe, diving ducks, Forster's tern, great blue heron, northern harrier

Emergent vegetation - tule

Fish - channel catfish, common carp, largescale sucker, mountain sucker, mountain whitefish, Pacific lamprey, salmon, small mouth bass, trout, white sturgeon

Fungi - as a taxon

Macrophytes - Columbia yellowcress, water milfoil

Mammals - beaver, coyote, mule deer, muskrat, raccoon, weasel, western harvest mouse

Reptiles - side-blotched lizard, western garter snake

Terrestrial vegetation - black cottonwood, dense sedge, ferns, reed canary grass, rushes, white mulberry

Scenarios of Interest

Although the scope of the screening assessment is current conditions, the scenarios developed for the human health assessment considered potential uses. Twelve human exposure scenarios were developed that covered a wide range of potential exposures. The scenarios included basic Hanford Site Risk Assessment Methodology (HSRAM) scenarios as well as several CRCIA scenarios developed to evaluate variables such as short-to-long exposure times, small-to-large ingestion rates of local foods, and multiple combinations of exposure pathways. CRCIA Team input was critical in the definition of Native American scenarios. Scenarios included in the human health screening assessment are listed below (see Section 5.1):

Industrial/commercial scenarios - industrial worker, fish hatchery worker

Wildlife refuge/wild and scenic river scenarios - ranger, avid recreational visitor, casual recreational visitor

Native American scenarios - subsistence resident, upland hunter, river-focused hunter and fisher, gatherer of plant materials, Columbia River island user

General population scenarios - resident, agricultural resident

Data Collection and Processing

A detailed search for environmental measurements collected from 1990 through early 1996 was made. Hanford and non-Hanford sources were queried, including Hanford contractors, local municipalities, the States of Washington and Oregon, and federal agencies. Data were collected for contaminant measurements in Columbia River water, riverbank seep water, Columbia River sediment, riverbank seep sediment, interstitial water (interface between groundwater and the river within the river bottom), riparian zone soils, aquatic and riparian zone biota, external radiation, and Hanford Site groundwater. Near river groundwater was used as a surrogate for riverbank seep water in those segments not having any results on the seep water itself. As a result of the data queries, a very large CRCIA database was established.

While the CRCIA database was extensive, there were many locations where contaminant measurements were not made during the time period of interest. Consequently, data were not always available for all contaminants of interest in all segments. For these cases, a series of surrogation and extrapolation rules were devised to allow approximation of the local contamination levels. Surrogate data were used where contaminant data from one medium were substituted for another medium within the same segment. For instance, groundwater data were used where no riverbank seep data existed. Extrapolated data were used for the same medium where contaminant data from one segment were substituted for another. In these cases, river water from an upstream segment was used in downstream segments.

Once the database was established, the data were prepared for use in the screening assessment. A data outlier test removed a maximum of one data point from each contaminant/medium/segment combination as appropriate. A trend analysis was also performed on these combinations to determine the most representative maximum data point. If an obvious downward trend was observed, the most recent data point was selected. Datasets were prepared for each segment for use in the deterministic and stochastic assessments. The deterministic assessment utilizes maximum contaminant concentrations within each segment for the various media. The deterministic assessment employs reasonable maximum individual parameters, tends to generate larger (conservative) exposures, and is commonly used in typical regulatory risk assessment methodology. The stochastic assessment, on the other hand, utilizes the geometric mean and geometric standard deviation, which describe the distribution of the contaminant concentrations for each segment. The stochastic assessment output includes a range of risk exposures and risk coefficients, which describe the distribution of potential risks for each segment.

Ecological and Human Health Assessments

Computational models were developed for both the ecological and human health assessments. A complex spreadsheet application was utilized in the ecological assessment while a computer code application was used in the human health assessment. To the extent possible, ecological and human input parameters were kept consistent. Transfer factors in human health models were derived from the ecological model results. The models and input parameters are described in Sections 4.2 and 5.2 and the appendixes. The models were tested and verified prior to their use.

To attempt to quantify the uncertainty, two calculation methods were used: deterministic and stochastic. For the deterministic method, the equations were calculated with single, high values of the parameters to identify potential worst case results. For the stochastic method, the equations were calculated with all possible combinations of parameter values, resulting in an output distribution rather than a single value.

For the human health assessment, both deterministic and stochastic calculations were performed for all contaminants, all scenarios, and all river segments. The contaminants assessed fall into one of three categories (carcinogenic chemicals, toxic chemicals, and radionuclides), each of which result in a different type of risk. Individual calculations for each of these contaminant/scenario/segment combinations are compared with toxicity or carcinogenicity indices as appropriate.

For the ecological risk analysis, deterministic calculations were performed for all species/contaminant/segment combinations. However, stochastic calculations were only performed for those combinations that resulted in an Environmental Hazard Quotient (EHQ) greater than 1.0. Results of the stochastic calculations were compared with toxicological benchmarks, including the lowest observed effect level (LOEL) and the lethal concentration (LC_{50}).

A benefit of the use of stochastic calculations was that it enabled the results to be subjected to statistical comparisons. In these comparisons, the stochastic distribution of concentrations and resulting risk in each Hanford-influenced river segment could be compared to those in a background segment upstream and out of the influence of the Hanford Site. These comparisons provide insight into the nature and magnitude of the incremental risks posed by Hanford releases and identify areas of concern.

Supporting information relative to the respective sections and appendixes in Part I has been published on diskettes, which have been issued with limited distribution. In addition, because numerous changes have occurred in Volume II of the draft data report since its initial publication in June 1996, a revised Volume II is being issued, also with limited distribution. The CRCIA report with its diskettes and the updated version of Volume II of the June 1996 data report with its diskettes are available on the Internet at http://www.hanford.gov/crcia/crcia.htm. Both the diskettes and hard copies of Volume II are also available from S.D. Cannon (509-372-6210).

Results and Discussion

The results of the ecological and human health screening assessments are provided in Sections 4.2 and 5.2, respectively. As a result of Hanford Site operations as well as from other human activities upstream of the Hanford Site, environmental levels of some contaminants do appear to be elevated. Both the ecological modeling and human exposure simulations identify contaminants and locations for which risk to both the environment and humans is evident and for which further analyses or measurements would be worthwhile.

Figure S.1 is a high-level summary of the findings of the ecological risk and human health risk assessments. The contaminants and affected segments of the Columbia River that pose a potential risk according to the results of either the ecological or human risk assessments are identified. The overlapping

Figure S.1. Summary of the Screening Assessment of Risk to the Ecosystem and Human Health (The reporting thresholds in this figure identify potentially hazardous contaminants, chronic and acute effects to all plants and animals, and toxic and carcinogenic impacts on human health for all scenarios considered in this report.)

		Minimal risk																									
		Ecological risk above threshold defined in Section 6.3																									
		Human risk above threshold (>IE-6 lifetime risk >0.01 hazard index)																									
		Above both ecological and human risk thresholds																									
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
	Priest	B/C		KE/KW	K-	N		D		H		White	F	F		Hanf.	Hanf.	Supp.		300	1100		Yakima	Snake	Boise	Walla	McNary
Analyte	Rapids	Area		Area	Trench	Area		Area	Horn	Area		Bluffs	Area	Slough		Slough	Town.	Sys.		Area	Area	Richland	Riv.	Riv.	Casc.	Walla R.	Res.
Ammonia																											
Benzene																											
C-14																											
Cs-137																											
Cr/Car																											
Co-60																											
Copper																											
Cyanide																											
Diesel																											
Eu-152																											
Eu-154																											
I-129																											
Kerosene																											
Lead																											
Mercury																											
Np-237																											
Nickel																											
Nitrate																											
Nitrite																											
Phosphate																											
Sr-90																											
Sulfate																											
Tc-99																											
Tritium																											
U-234																											
U-238																											
Xylene																											
Zinc																											

results of the two assessments are also identified. For most of the contaminants, segments identified by the ecological risk analysis were also identified by the human health analysis, but sometimes the contaminants were in media that affect biota more directly than humans, so that human risk for those contaminant/segment combinations is below the reporting threshold. Conversely, segments identified via the human health analysis having indications of increased potential risk were not always identified in the ecological analysis.

The reporting thresholds used in Figure S.1 to identify potentially hazardous contaminants include consideration of chronic and acute effects on the environment and toxic and carcinogenic impact on humans. For the chronic ecological effects, a contaminant is identified if the number of stochastic simulation results exceeding a chronic toxicity benchmark is more than 5 percent greater than the number estimated in the background segment for the contaminant (denoted by yellow in Figure 4.19 of Section 4.2). For the acute ecological effects, a contaminant is identified as potentially hazardous if the sum of acute risk indices across all species for a contaminant is more than twice the equivalent total for the background segment (denoted by red in Figure 4.19 of Section 4.2). For humans, a contaminant is identified as potentially hazardous if the estimated hazard index for a given contaminant for any scenario is greater than 0.01 or if the estimated lifetime risk for any scenario is greater than 10^{-6}.

The contaminants identified in Figure S.1 as potentially hazardous are listed in Table S.1 with additional details about the magnitude and sources of the potential risk. Table S.1 presents the contaminants of highest potential risk identified in either the ecological risk assessment or the human health risk assessment, the segments in which they were identified, the medium or media that provided the dominating component of the risk, and the range of estimated human risk. To demonstrate the range of human risk, the median stochastic values of lifetime risk (carcinogenic chemicals and radionuclides) and hazard index (toxic chemicals) for both the Ranger and Native American Subsistence Resident scenarios are given.

The ecological assessment identified the types of organisms most likely to be adversely affected. Terrestrial species that are potentially most affected by contaminants in the study area are swallows, mallards, American coots, harvest mice, Canada geese, and raccoons. However, risk within the study area that is above background levels is limited to only a few locations within the study area (see Figure 4.22 in Section 4.2). The other species, including bald eagles, have relatively low risk in both absolute and relative (to background) terms. Aquatic species most likely to be affected by acute or chronic toxic effects from contaminants of Hanford Site origin are Columbia pebblesnail, hyalella, daphnia magna, crayfish, Woodhouse’s toad, suckers, clams, mussels, and salmon/trout larvae. Most of these aquatic organisms have a benthic life style, spending all or a high proportion of their life in direct contact with sediment or pore water, and the pore water concentrations tend to drive their body burdens. A key pathway of exposure for the terrestrial organisms is predation of the aquatic species with high body burdens, which is also ultimately related to the concentration of contaminants in pore water.

Contaminants of interest pose potential hazards to some plants, herbivores, omnivores consuming riverine organisms (especially insects as prey), and weasels in some areas. The primary contaminants driving the risk are cesium-137, chromium, cobalt-60, lead, mercury, technetium-99, and zinc. The media contributing most to risk are pore water and sediment. For aquatic species, the organisms most at risk are

Table S.1. Potentially Hazardous Contaminants Identified by River Segment and Contaminating Media (This table presents the contaminants by river segment and media and the estimated range of human risk.)

	Ecological Risk		Human Risk					
	River		River		Ranger Scenario		Native American Sc.	
Contaminant	Segment	Medium	Segment	Medium	Haz. Index	Risk	Haz. Index	Life Risk
Benzene			5	SP				2.60E-05
			13	SP				2.60E-05
Carbon-14			4	SP				2.90E-05
			6	SP				1.20E-05
Cesium-137			2	SW				7.01E-06
			3	SW(2)				7.46E-06
			4	SW(2)				1.06E-05
			5	SW(2)				1.32E-05
			6	SW				1.76E-05
	7	SD	7	SW(6)				2.16E-05
			8	SW				2.78E-05
			9	SW(8)				2.81E-05
	10	SD	10	SW(8)				3.06E-05
			11	SW(8)				2.94E-05
	12	SD	12	SW(8)				2.92E-05
			13	SW(8)				3.32E-05
			14	SW(8)				2.43E-05
			15	SW(8)				2.39E-05
			16	SW(8)				2.63E-05
			18	SW				1.34E-05
			19	SW(18)				2.05E-05
			21	SP(GW)				1.59E-05
Chromium	2	SD+SP	2	SW+SD		2.60E-04	2.32E-02	2.58E-01
	4	SD+SP	4	SD+SP		2.10E-04	3.30E-02	1.09E-01
	5	SD+SP	5	SD		2.10E-04	1.43E-02	6.30E-02
			6	SW		5.90E-05		4.23E-02
			7	SD		1.50E-04		6.94E-02
			8	SW+SP		5.60E-05	1.35E-02	8.66E-02
	9	SD+SP	9	SD+SP		1.00E-04	2.46E-02	6.72E-02
	10	SD+SP	10	SD+SP		1.40E-04	1.71E-02	5.90E-02
			13	SD		7.20E-05		5.28E-02
			18	SD		1.90E-04		3.89E-02
			19	SD		2.50E-04		1.05E-01
			20	SD		1.60E-04		7.03E-02
			27	SD		1.50E-04		1.64E-02
Cobalt-60			2	SD				3.54E-06

Table S.1. (Cont'd)

	Ecological Risk		Human Risk					
	River		River		Ranger Scenario		Native American Sc.	
Contaminant	Segment	Medium	Segment	Medium	Haz. Index	Risk	Haz. Index	Life Risk
(Diffuse)			3	SW(2)				2.22E-06
			4	SW(2)				2.96E-06
			5	SW(2)				2.71E-06
	6	SD	6	SD				1.08E-05
	7	SD	7	SD				2.58E-06
	8	SD	8	SW				3.71E-06
	9	SD	9	SD				2.49E-06
			10	SW(8)				1.86E-06
			11	SW(8)				2.16E-06
	12	SD	12	SW(8)				2.04E-06
	13	SD	13	SP(GW)				6.61E-06
			14	SW(8)				1.55E-06
			15	SW(8)				2.08E-06
			16	SW(8)				2.08E-06
			17	SP				2.15E-06
			18	SW				3.49E-06
			19	SW(18)				8.46E-06
			21	SP(GW)				2.89E-06
Copper	4	SP	4	SD			2.35E+00	
			11	SD			2.57E+00	
			14	SD			2.79E+00	
			17	SD			2.51E+00	
	20	SP						
			23	SW			6.51E+00	
			24	SW(23)			4.28E+00	
			25	SW(23)			6.32E+00	
			26	SW(23)			5.30E+00	
			27	SW(23)			6.90E+00	
Cyanide	20	SP(GW)						
	21	SP(GW)						
Europium-152			13	SP(GW)				6.30E-05
Europium-154			6	SP				2.92E-06
			8	SP				9.23E-06
			13	SP(GW)				1.26E-05

Table S.1. (Cont'd)

	Ecological Risk		Human Risk					
	River		River		Ranger Scenario		Native American Sc.	
Contaminant	Segment	Medium	Segment	Medium	Haz. Index	Risk	Haz. Index	Life Risk
			17	SW				3.13E-06
			18	SW(17)				3.15E-06
			20	SP				1.68E-06
			21	SP(GW)				1.47E-05
Iodine-129			19	SP(GW)				2.20E-06
Lead	2	SD+SP						
	3	SD+SP						
			4	SD			4.30E-01	
	5	SD+SP	5	SD			3.65E-01	
	7	SD+SP						
	9	SD+SP						
	13	SD+SP						
	17	SD+SP	17	SD			1.22E+00	
	19	SD+SP	19	SD			6.47E-01	
	20	SD+SP	20	SD			4.74E-01	
	21	SD+SP						
			22	SW(21)			3.78E-01	
Mercury	3	SD						
	4	SD						
	6	SD						
	8	SD						
	9	SD						
	10	SD						
	12	SD						
	13	SD						
	14	SD						
	15	SD						
	16	SD						
	19	SD+SP						
	20	SD+SP						
Neptunium-237			8	SD				6.50E-05
			9	SD				8.30E-05
Nickel	20	SD						

Table S.1. (Cont'd)

	Ecological Risk		Human Risk					
	River		River		Ranger Scenario		Native American Sc.	
Contaminant	Segment	Medium	Segment	Medium	Haz. Index	Risk	Haz. Index	Life Risk
Nitrates			4	SP			1.56E-01	
			10	SP			1.05E-01	
			12	SP(GW)			8.88E-02	
			14	SP			1.42E-01	
			17	SP			1.38E-01	
			20	SP			2.39E-01	
Nitrites			19	SP			1.08E-02	
Strontium-90			2	SD				8.35E-06
			3	SD				6.72E-05
			4	SW(3)				1.07E-05
			5	SD				1.28E-04
			6	SD				6.72E-04
			8	SP				1.79E-05
			9	SW				1.41E-05
			10	SD				1.10E-04
			12	SW(10)				6.43E-06
			13	SD				4.38E-05
			15	SD				5.95E-05
			16	SW				2.97E-05
			20	SW				6.09E-06
			21	SW				5.36E-06
			24	SW(21)				6.45E-06
			26	SW(21)				5.83E-06
			27	SW(21)				6.57E-06
Sulfates			7	SP(GW)			1.14E-02	
Technetium-99			3	SD				2.84E-06
	8	SD	8	SD				1.18E-06
	9	SD	9	SD				9.61E-07
	10	SD	10	SD				2.80E-06
	14	SD						
			17	SD				1.34E-06
	19	SD	19	SD				2.51E-06
Tritium (Hydrogen-3)			2	SP				1.31E-05
			4	SP(GW)				6.70E-06

Table S.1. (Cont'd)

	Ecological Risk		Human Risk					
	River		River		Ranger Scenario		Native American Sc.	
Contaminant	Segment	Medium	Segment	Medium	Haz. Index	Risk	Haz. Index	Life Risk
			6	SP				1.70E-05
			8	SP				5.05E-06
			9	SP				4.31E-06
			17	SP				2.15E-04
			19	SP(GW)				2.38E-05
			20	SP				8.91E-06
Uranium-234			12	SD				4.62E-05
			14	SP				7.34E-05
			17	SP				7.62E-05
			20	SP				9.34E-04
Uranium-238			4	SD				5.18E-05
			10	SD				1.51E-04
			11	SD				4.93E-05
			12	SD				4.54E-05
			14	SP				6.49E-05
			17	SD				5.81E-05
			19	SW+SP				1.07E-04
			20	SP+SD				8.67E-04
Zinc	4	SP+SD	4	SD			1.72E-01	
	7	SP+SD						
	8	SP+SD						
			12	SP(GW)			3.78E-01	
			16	SD			1.47E-01	
	17	SP+SD	17	SD			1.59E-01	
			19	SD			2.29E-01	
	20	SP+SD						
GW	= Groundwater		SP(GW)	= Seep water surrogated with groundwater				
SD	= Sediment		SW	= Surface water				
SP	= Seep water		SW(21)	= Surface water extrapolated from upstream Segment 21				
Note: Only human risk values greater than 1.0E-6 or a hazard index of 0.01 are shown.								

benthic species or life stages. Contaminants contributing to their risk are chromium, copper, cyanide, lead, mercury, and zinc. The media contributing most to this risk are pore water and sediment, with pore water most significant.

The segments presenting the greatest potential ecological risk are Segment 2 (chromium and lead at the 100-B/C Area), Segment 4 (chromium, copper, mercury, and zinc at the 100-K Area), Segment 5 (chromium and lead), Segment 6 (cobalt-60 and mercury at the 100-N Area), Segment 7 (cesium-137, cobalt-60, lead, and zinc at the 100-D Area), Segment 8 (cobalt-60, mercury, and technetium-99), Segment 9 (chromium, cobalt 60, lead, and mercury), Segment 10 (cesium-137, chromium, mercury, and technetium-99 at the 100-H Area), Segment 12 (cesium-137, cobalt-60, and mercury), Segment 13 (cobalt-60, lead, and mercury at the 100-F Area), Segment 14 (mercury and technetium-99), Segment 16 (cobalt-60 and mercury), Segment 17 (lead, but results suspect and zinc), Segment 19 (lead and mercury), Segment 20 (cyanide, lead, mercury, technetium-99, and zinc at the 300 Area—all results suspect), and Segment 21 (cyanide and lead).

Segments with potential acute ecological risk are Segment 4 (chromium and zinc), Segment 5 (lead), Segment 8 (mercury), Segment 9 (chromium, lead, and mercury), Segments 10 and 14 (mercury), Segment 13 (lead and mercury), Segment 17 (lead), and Segment 20 (copper and zinc). Data were insufficient to assess ecological risk of any contaminant in Segments 11, 18, and 22-27. Risk from nitrite, sulfate, and phosphate was not evaluated because of the general lack of toxicity benchmarks. They present no risk from food-chain exposure, however, because they are readily metabolized. Risk from neptunium-237 and carbon-14 was not evaluated because of the lack of pore water data. Surface water data for europium-152 were absent in Segments 1-18, so risk from this isotope was not estimated in those segments. Risk from certain other contaminants was not evaluated in all segments because of missing pore water data (see Figure 4.19 in Section 4.2).

The human health analysis identified the categories of humans most likely to be affected. Humans in the region of the Hanford Site may have a wide variety of exposures, from low to high (see Figures 5.1-5.3 in Section 5.2.3.1). Generally speaking, the scenarios for the Fish Hatchery Worker, Industrial Worker, and Ranger have the lowest exposures and, therefore, are lowest in terms of health risk. As defined in Section 5.1, none of the people involved in these scenarios consume foods grown in the Columbia River riparian zone or drink seep water. Therefore, the exposures are mostly incidental external exposures and inhalation of resuspended materials, though the Fish Hatchery and Industrial workers also consume a moderate amount of Columbia River water. The risk to workers from these pathways is quite low in comparison to those projected for people potentially exposed in other ways. At the other extreme, people postulated to live along the Columbia River, to eat substantial quantities of foods grown in the riparian zone, to eat fish and wildlife from the river, and to drink seep water have much larger potential exposures and, thus, estimated health risk. This category encompasses nearly all of the remainder of the scenarios described in Section 5.1. From a risk assessment standpoint, very few differences appear between any of the Native American scenarios and recreational/residential scenarios.

The segments presenting the greatest potential human health risk for any given scenario are as follow (these are identified using the estimated hazard index greater then 1.0 and/or an estimated lifetime risk greater than 1E-4): Segment 2 (chromium), Segment 4 (chromium and copper), Segments 5 and 6 (chromium and strontium-90), Segments 7-9 (chromium), Segment 10 (chromium, strontium-90, and uranium-238), Segment 11 (copper), Segment 13 (chromium), Segment 14 (copper), Segment 17 (copper, lead, and tritium), Segment 18 (chromium), Segment 19 (chromium and uranium-238), Segment 20 (chromium and uranium-238), Segments 23-27 (copper).

Data were not available in every segment for all contaminants in all media. Data availability is discussed in Section 3.0, where lack of specific contaminant data is identified by segment. Surface water data for europium-152 were absent in Segments 1-18, so risk from this isotope was not estimated in those segments. Segments 11, 18, and 22-27 did not have sufficient seep water data (or a groundwater surrogate), so this medium was not included in the human health assessment in these segments. Seep water was generally not the primary contributor to potential human health risk, however, as indicated in Table S.1. Surface water data were extremely limited downstream of Segment 21 and were, therefore, extrapolated from Segment 21 for Segments 22-27 with few exceptions.

Uncertainty is inherent in any risk assessment. The uncertainty within the ecological and human health assessments is discussed in Sections 4.2.10 and 5.2.3.3, respectively. Uncertainties include those associated with the exposure models, measured media data, representativeness of the data, use of surrogate and extrapolated data, exposure scenarios, accuracy of modeled processes, and toxicological and dose response references.

Hanford and Non-Hanford Sources of Contaminants

Contaminants present in the Columbia River environs result from operations at Hanford as well as from human activities upstream of the Hanford Site. Contaminants for which a Hanford source appears to be indisputable include ammonia, cesium-137, chromium, cobalt-60, europium-152, europium-154, nitrates, strontium-90, technetium-99, tritium (hydrogen-3), and uranium isotopes. Other contaminants for which the Hanford Site may be a contributor, at least at specific locations, include copper, cyanide, lead, mercury, and zinc. The analyses indicate relatively high potential risk from these latter contaminants. However, the upstream risk from these contaminants is also high, and the Hanford Site increment over the upstream value is generally factors of two to three or less, making exact identification difficult.

Potentially Hazardous Contaminants

The contaminants discussed here are those identified by the ecological and human health screening assessments to be potentially hazardous (see Figure S.1 and Table S.1). The intent of the discussion of each potentially hazardous contaminant is to enhance the understanding of the potential risks and focus possible remedial decisions on those contaminants and media with the potential for the greatest risk reductions.

Benzene. Benzene is seen in low concentrations in seep water, frequently in conjunction with xylenes. It is a measurement surrogate for petroleum hydrocarbons. Some instances of petroleum contamination are known at the Hanford Site. The highest levels are seen at the 100-K and 100-F Areas. The primary exposure pathway is consumption of seep water.

Carbon-14. Carbon-14 is not detected in surface water. The Native American and Resident scenarios are uniformly controlled by ingestion of carbon-14 derived from seep water. Seep water was surrogated with groundwater in almost all segments along the Hanford Site. A single, particularly high value in the 100-K Area is evident in the deterministic data.

Cesium-137. Cesium-137 is a constituent of worldwide fallout and is present in soil and river sediment both upstream and downstream of the Hanford Site. While the concentrations of cesium-137 in sediment are similar upstream, along, and downstream of the Hanford Site (Dirkes and Hanf 1996), there is greater variability in the measurements along and downstream of the site, indicating that localized zones of increased concentration may exist. The primary risk is to biota that burrow into or live on the sediment. The primary pathway is external irradiation of these biota. For humans, the scenarios with high fish consumption show somewhat elevated risks from surface water, but this is largely driven by the surrogation process from a very few measured segments.

Chromium. This metal is identified as existing in elevated concentrations in several Hanford Reach river segments. For biota, the primary media of concern are sediment and pore water within the sediment (modeled using measurements of seep water or groundwater), and for humans the primary media are also sediment and the associated seeps. This indicates that the primary problem is groundwater contamination inland of the areas of the seeps, which is resulting in contamination of the sediment around the point where the groundwater issues into the river.

Cobalt-60. This radionuclide exists in both discrete particulate form and as generalized diffuse contamination. The particles have higher discrete activity and are somewhat easier to detect, but the more significant problem is with the diffuse sources. As with cesium-137, the primary ecological problem is direct external irradiation of biota that burrow into the sediment contaminated with diffuse cobalt-60 contamination.

Copper. In general, the risk to humans or biota from copper is similar upstream and downstream of the Hanford Site. However, in absolute terms, this metal is one of highest risk to biota and humans. The modeling indicates that pore water (modeled using groundwater measurements) in the 100-K Area may be elevated, thus exposing biota. Copper is one of the metals that may also be enhanced from upstream sources.

Cyanide. The excess risk calculated for this chemical compound is associated with pore water (modeled using groundwater) for biota and with seep water (also modeled using groundwater) for humans.

Europium-152. Europium-152 is an activation product, similar in source to cobalt-60. Although discernible above background throughout the Hanford Reach in sediment, the risk to humans from europium-152 is primarily from ingestion of seep water in Segment 13.

Europium-154. Like europium-152, the activation product europium-154 is slightly elevated throughout the Hanford Reach. The primary exposures are via seep water, though the primary mechanism in Segments 17 and 18 is via surface water.

Iodine-129. Iodine-129 is detectable above background at very low levels in Hanford surface water, but the primary pathway of exposure is via drinking seep water. The only segment with concentrations measured sufficiently high to score over a risk of 1E-6 is Segment 19.

Lead. The risk to biota from lead is dominated by concentrations in sediment and pore water, and the risk to humans is dominated by concentrations in sediment. Lead is one of the metals that may also be enhanced in sediment from upstream sources, but there are signs that lead may be somewhat enhanced in Hanford Site groundwater, particularly in the vicinity of the old Hanford townsite.

Mercury. The risk from mercury is primarily to biota from sediment. Mercury is one of the metals that may also be enhanced from upstream sources.

Neptunium-237. The only positive measurements for neptunium-237 occur in sediment in Segments 8 and 9, which in the modeling lead to small ingestion intakes. These are single point measurements and do not represent wide area contamination.

Nickel. The ecological modeling identifies nickel in sediment as a possible problem in the 300 Area only.

Nitrates. The risk to humans from nitrates is derived from the pathway of drinking seep water. Nitrates are known to be elevated in Hanford Site groundwater with samples in groundwater above the U.S. Environmental Protection Agency drinking water standards in several of the reactor areas (see, for example, Dirkes and Hanf 1996).

Strontium-90. The primary risk to humans from strontium-90 comes from consuming foods grown in contaminated sediment. Risk from consumption of seep water comes in a close second. It is likely that the concentrations in the sediment are related to the seep water concentration at most of the locations that are coincident with reactor areas.

Sulfates. Sulfates are measured in surface water and seeps in numerous locations. The primary pathway is direct ingestion. The concentrations averaged in Segment 7 are slightly higher than elsewhere, but the risk from sulfates is generally low.

Technetium-99. Environmental concentrations of technetium-99 are not high, but the soil-to-plant uptake factor for technetium is very large. Vegetation has a strong propensity to concentrate technetium from soil. The key medium for technetium-99 is sediment. In the case of the ecological results, the risk is actually related to the chemical toxicity of technetium in plants. For the human health results, the risk is associated with consumption of food plants grown in the technetium-contaminated sediment in the riparian zone.

Tritium (Hydrogen-3). Tritium is widely distributed in Hanford Site groundwater. However, it has a low biological uptake and generally short retention time in plants and animals because it is associated with water. The primary route of exposure to humans is via consumption of seep water. The most extensive region where seep water contaminated with tritium enters the Columbia River is the vicinity of the old Hanford townsite.

Uranium-234/238. Although uranium is also ubiquitous in the environment, several areas have concentrations elevated above background levels. The media of interest include sediment and seep water near the 300 Area. A prominent pathway is the consumption of prey animals by animals farther up the food chain.

Zinc. The risk to biota is predominantly influenced by pore water and sediment. This metal provides the highest absolute contribution of risk to biota, but the median relative ratio to the upstream value is generally less than one for risk to humans. Zinc is one of the metals that may also be enhanced from upstream sources.

Screening Assessment Conclusions

By agreement with the Tri-Parties and the CRCIA Team, this screening assessment addressed the current potential for ecological and human risk, resulting from known levels of contaminants in the Columbia River or in its immediate vicinity.

The screening study posed the general questions:

- Do levels of contaminants in Columbia River water, sediment, and riparian zone materials pose a current threat to ecological resources?

- Do levels of contaminants in Columbia River water, sediment, and riparian zone materials pose a current threat to humans who might be exposed to them?

When taken in the context of the screening assessment, the answers to the two main assessment questions are yes. As a result of Hanford operations as well as from other human activities upstream of the Hanford Site, environmental levels of some contaminants do appear to be elevated. Both the ecological modeling and human exposure simulations identify further analyses or measurements would be worthwhile.

Through the use of multiple exposure scenarios, the possible activities of people who could come into contact with the contaminants were evaluated. In general, risk to people today is low because of restricted access to the Hanford Site. Casual visitors and even people working in jobs associated with the Columbia River are not at risk unless they frequent limited areas and consume seep or spring water in which high concentrations of contaminants are present. However, potentially increased risk is possible if people were to move onto the Hanford Site and derive large percentages of their daily food intake from crops and animals in the river's riparian zone. In most instances, this higher risk is limited in extent to a few regions of highest contamination. Although there are numerous cultural differences between the general population and Native Americans, the common pathways of food and water consumption could affect both groups. These common pathways are the ones by which most exposure would be received. The key differences come in the source of the water and food products.

Because of scientific uncertainty, the overall potential impact on the riparian ecosystems is not known. There is insufficient knowledge about the distribution of species, their migration patterns, and their interactions over the entire Hanford Reach. It is possible to say that there is a risk to individual members of certain species, those that frequent the locations of highest contamination.

Perspective

The CRCIA screening assessment was, by definition, limited in some respects. The screening assessment was restricted to current conditions, the area between Priest Rapids Dam and McNary Dam, a limited number of contaminants, a limited amount of monitoring data, a limited number of species, and a limited number of scenarios. For the results of the assessment to be useful, these limitations, the assumptions in the study, and the process through which the study was conducted must be understood and considered in context with the intended use. Site-specific considerations should be added to the general results presented here during the decision-making process to ensure responsible actions that are protective of the Columbia River.

The analyses completed for the screening assessment are based on the currently available data. Information is not available for all contaminants in all river segments during this time period. Where appropriate, data were extrapolated or surrogated to fill some of the data gaps, but others remain. The final results of the screening assessment, therefore, are limited by the scope constraints and the available information. The assessments have indicated that there are portions of the Hanford Reach of the Columbia River in which concentrations of contaminants, particularly in sediment and groundwater, are relatively high, pose a potential risk to human and ecological receptors under some scenarios, and may warrant additional investigation.

The density of data available for the assessment is illustrated in Section 3.0. For some river segments, relatively few data were available during the study period. These are areas for which additional sampling may be advisable. However, before proceeding with additional sampling or any remedial action, considerations must be made of additional information not used in this analysis and of the likelihood of acquiring additional useful information. For example, systematic radiological surveys have been made in the past (Sula 1980, EG&G 1990) that indicate the potential for finding additional highly radiologically contaminated areas along the river is small.

The spatial extent of the river segments as defined for the analysis is large enough to partially mask the presence of hot spots. The stochastic risk results tend to average out over segments as much as a few miles long. As a result of this and the data density issue discussed above, it is not possible to state categorically that elevated levels of contaminants do not exist in areas other than those previously identified.

Recent studies of rivers other than the Columbia also provide indications that the Hanford Reach is not unique (Pinza et al. 1992). Contaminants in Columbia River water, groundwater, seep water, sediment, and soil may have potential for impact on human or ecological health in areas immediately adjacent to the Hanford shorelines or throughout the Hanford Reach. However, there are sources of contaminant, primarily heavy metal, releases to the Columbia River upstream of Hanford. Thus, there are amounts of these metals, particularly chromium, copper, lead, mercury, and zinc, in sediment and water being transported through the Hanford Reach from operations such as mining upstream (Munn et al. 1995, Serdar 1993, Johnson et al. 1990). Recent events (Tri-City Herald 1997) have shown that upstream tributaries of the Columbia River may carry very high levels of metals, particularly during periods of high runoff. The concentrations are sufficient to be acutely toxic to wildlife. The source of contaminants must be considered when evaluating Interim Remedial Measure alternatives.

Contaminant metals tend to sorb to fine-grained sediments, which deposit in slack water areas. Sizable quantities of sediments are deposited in the study area in the Hanford sloughs as well as behind both Priest Rapids Dam upstream (a portion of Segment 1) and McNary Dam downstream (Segments 22-27). This variation in sediment deposition and the variation in the sediment composition (grain size and organic content) may help explain some of the assessment results. A clear understanding of the these complex relationships is essential to ensuring the environmental data and the resultant analyses using these data are accurately interpreted.

In addition, the bioavailability of some of these heavy metals has been identified as a significant source of uncertainty in the ecological assessment. These metals serve as nutrients and are known to be self-regulated, depending on the amount of the nutrient/contaminant present in the environment. As a result, transfer factors for these contaminants are highly variable and often times over- or underestimated when used in ecological assessments. A better understanding of the bioavailability of these contaminants in the Hanford Reach would allow for a more accurate estimate of the risk associated with these contaminants.

The scenarios used to establish the potential for human exposure, defined in Section 5.1, all have a common starting assumption: the individual described performs all of the described activities within the selected segment and within the river or immediately adjacent riparian zone. The likelihood of a person's actually deriving all of her or his food and water from the ripanian zone has not been included in the scenario definitions. However, to simplify the analyses and provide a common basis for comparison, the same assumptions have been used for all river segments. Thus, while the results discussed above may indicate potential risk for various residential scenarios, the probability of occurrence of such activities is not considered in this assessment.

The ecological risk evaluated is for injury to individual plants or animals. The current state of scientific knowledge does not allow extrapolation to impact on the ecosystem with this level of information. Human risk is limited to individual toxic response or long-term carcinogenicity. The scenarios do not address cultural impact or multigenerational impact of the exposures.

The CRCIA screening assessment has provided an extensive amount of information relative to the human health and ecological risk associated with Hanford-origin contaminants in the Columbia River environment. The assessment has been successful in identifying contaminants that pose a significant potential risk. In addition to humans, ecological receptors most likely to be exposed to elevated levels of contaminants have been identified. The assessment has also identified in what media the contaminants are concentrated and through what pathway the contaminants reach the receptors. In addition, the locations of the problem areas have been identified within the spatial scale provided for in the assessment. Finally, the assessment defines the activities that could result in an adverse exposure to the contaminants. Clearly, the screening assessment provides relevant and meaningful information to support Interim Remedial Measure decisions, to help guide ongoing environmental surveillance programs, and to focus a subsequent and more comprehensive assessment.

Part II. Requirements for a Comprehensive Assessment

As the screening assessment documented in Part I was being conducted, the assessment specified in Part II was developed by the CRCIA Team. Active participants on the CRCIA Team have been representatives from the Confederated Tribes of the Umatilla Indian Reservation, Nez Perce Tribe, Yakama Indian Nation, Hanford Advisory Board, Oregon State Department of Energy, Tri-Party agencies, and Hanford contractors. The CRCIA Team developed Part II to explicitly require any future assessment of Hanford impact on the Columbia River to embody, at a minimum, the methods, characteristics, and controls described in Part II. Those analyses involving the Columbia River that adhere to the spirit and substance of these requirements are far more likely to be acceptable to the governments and institutions that authored this section and far more meaningful in guiding cleanup decisions.

The authority underpinning these requirements for a comprehensive assessment of Hanford impact on the Columbia River is the U.S. Department of Energy's (DOE's) need for acceptance of cleanup decisions and this assessment's results by the affected people. DOE is providing only publications services for Part II of this report. It is not issued as an expression of DOE's endorsement. Like DOE, the other Tri-Party agencies (Washington State Department of Ecology and the U.S. Environmental Protection Agency), are members of the CRCIA Team that originated these requirements. However, these requirements have been promulgated by the CRCIA Team, not by the Tri-Party agencies, even though preparation of these requirements is the subject of Tri-Party Agreement commitments (milestone M-15-80).

This is the only composite assessment of how effective the cleanup of the Hanford Site will be as expressed in terms of impact to the Columbia River. Other analyses address only some of the elements of the needed assessment. This is a composite assessment because, in part, all potentially harmful radioactive and chemical materials within the Hanford Site boundary (those planned by DOE, to exist at the completion of cleanup) are included in a single evaluation of impact resulting from potential exposure. The purpose of CRCIA is to assess the effects of Hanford-derived materials and contaminants on the Columbia River environment, river dependent life, and users of river resources for as long as these contaminants remain intrinsically hazardous. This purpose is envisioned to be carried out by developing a suite of integrated analysis tools, which would be used for each revision of DOE's intended waste disposal plans defining the Hanford Site's final state. As such, CRCIA becomes a major, critical part of the Hanford Site's final baseline risk assessment. CRCIA is

> WHAT IS DOE's COMMITMENT
> TO CRCIA AND THESE REQUIREMENTS?
>
> DOE is pursuing follow-on work based on the "Requirements for a Comprehensive Assessment." As part of completing TPA Milestones M-15-80A, M-15-80B, and M-15-80B-T01, DOE is working with the CRCIA Team to identify specific work tasks that 1) are necessary for a comprehensive assessment, 2) are prioritized and address the most dominant risk factors first, and 3) can be performed within budget guidelines. Agreed to tasks will be included in the multi-year work plan packages for FY 1998 and beyond.

also seen as a tool with which effectiveness can be estimated for each of the alternatives considered in strategic planning exercises, environmental impact statements, and the various projects' studies. This assessment was defined and this part of the report was prepared by the CRCIA Team (not DOE or its contractors) under a new public involvement paradigm described later in this summary, in Section 4.0, and in Appendix II-D.

In facing the question of what constitutes a comprehensive assessment, a serious problem soon became apparent: How can the assessment include all of the factors significant to potential river impact while keeping the effort to a manageable size which can be funded? Using expert judgment to "assume the assessment down-to-size" was rejected as an acceptable solution to this problem. Instead, a principle (specified as a requirement in Part II) was borrowed from other industries that routinely deal with large, complex problems yet have only limited resources. This principle requires the study's planning process be based on sensitivity analyses and parametric analyses that sort the dominating factors from the smaller contributors to impact. Consequently, for any given level of resources allocated to this assessment, the biggest contributors to potential river impact will always be addressed. The challenge for analyst and manager alike is not to arbitrarily discard parts of the assessment to cut it down to size but rather to ensure that no factor is left out that would dominate the study results. Care has been taken in developing Part II to be fiscally responsible in defining the requirements for the technical work that must be conducted regardless of speculations on probable funding availability or limits presumed to exist in analytical methods, data collection techniques, or related technologies. Every effort has been made to ensure that the assessment will always focus on major contributors in such a way as to avoid obfuscation by the enormous number of smaller considerations.

Because the screening assessment in Part I of this report was scoped to be a less-than-comprehensive, limited-resource effort focused on identifying the most significant existing effects on the Columbia River, the comprehensive assessment in Part II subsumes the screening assessment in identifying both existing and future effects from the composite of all Hanford activities. In spite of the care in developing this report, it is recognized that it can and should be improved on, especially in view of inevitable changes in waste disposal plans and experience gained in conducting this and similar assessments. It is intended that this be a living document with changes controlled by the authoring institutions.

Part II defines a new paradigm for predecisional participation by those affected by Hanford cleanup decisions. The CRCIA Team developed the requirements in Part II as well as the approach and structure for conducting and managing future assessment work. Appendix II-D describes this new paradigm and the associated management requirements. It is recognized that some time may be needed to make the adaptations in existing Hanford practices this new paradigm calls for. An implementation period is anticipated during which special attention will be given to working within existing policies and procedures while adaptations are being made.

Following the Introduction and the discussion of Principles and General Requirements, Part II is divided into four key sections: WHAT is to be analyzed, HOW WELL must the results represent actual and future impact to the Columbia River, technically HOW is the assessment to be performed, and what is the MANAGEMENT structure for the analysis work. Explanations and descriptions of these four areas are found below. Lists of the technical requirements parallel this structure in Appendixes II-A, II-B, II-C, and II-D. The parallel sections/appendixes are:

- Section 1.0/Appendix II-A, What the Assessment Must Include. These sections specify WHAT factors must be included in assessing river impact. They include the extent of Hanford Site activities and materials to be addressed, transport mechanisms and travel times, and contaminant introduction into the river. The requirements also address the distribution of the contaminants within the Columbia River as well as identification of habitat or other water uptake locations. The requirements specify potential species, ecosystems, human populations, and cultures that could be affected by Hanford-derived contaminants in the Columbia River. These sections also include probable scenarios for the time frame of interest in which substantive change occurs to the river or ecosystem and cultural dependency on the river.

- Section 2.0/Appendix II-B, How Good the Impact Assessment Results Must Be. Requirements in these sections prescribe how complete the assessment results must be and HOW GOOD the analysis must be to produce the needed results.

- Section 3.0/Appendix II-C, Analytical Approach and Methods. Given the factors specified in the first two sections (1.0 and 2.0), these sections stipulate HOW the technical analyses are to be planned to ensure no dominant contributor is overlooked. Analytical methods, modeling requirements, data quality, uncertainty, and verification requirements are among the specifications included. While these requirements avoid specifying what tasks must be done or in what sequence work is to be performed, it is clear that this section must heavily influence how the assessment work is to be defined and the preparatory work that must precede the start of the analysis.

- Section 4.0/Appendix II-D, Conducting and Managing the Assessment. MANAGEMENT requirements are addressed in these sections to include methods to determine funding prioritization, sequence of technical work, roles of peer reviewers, integration with Hanford Site strategic planning and other analyses, and support of environmental impact statement preparations. These sections also address the continuing involvement and authority of affected people and groups.

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